Application No.: 10/605,990 Docket No.: BUR920020122US1
21806-00151-US1

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AMENDMENTS TO THE SPECIFICATION

Please AMEND the Specification in the instant application as follows:

-Please replace paragraph 21 with the following amended paragraph:

[0021] Relationships exist between electrostatic systems and thermostatic systems that can be used in analyzing complex heat flow problems related to EM in IC devices. In particular, the behavior of charge flux density D in an electrical circuit system is analogous to the behavior of heat flux density $\underline{\phi}$ in a thermal heat flow system. The analogous behavior of these two types of flux densities can be used to link the methods used for the analysis of elements in electrical and thermal systems.

-Please replace paragraph 29 with the following amended paragraph:

[0029] The heat equation for a thermostatic system can be written as:

$$\underline{\nabla \cdot (\kappa \cdot \nabla T) = -P_d} \qquad (2)$$

-Please replace paragraph 30 with the following amended paragraph:

[0030] where: $\underline{\nabla \mathbf{T} \quad = \nabla T(x,y,z)}$ = temperature gradient;

-Please replace paragraph 35 with the following amended paragraph:

[0035] In accordance with the above discussion, tools for the simulation and analysis of Poisson's equation and IC device interconnects can also be applied to solving the heat equation. Non-limiting examples of such tools include but are not limited to the electrical circuit simulators Hspice, Raphael, c2d, and any electromagnetic field or Poisson problem solvers. Each of these tools often includes capacitance and/or resistance extraction capabilities. In addition, these tools often include the ability to determine temperature distributions and temperature

PAGE 2/14 * RCVD AT 5/31/2005 4:13:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-1/3 * DNIS:8729306 * CSID:202 293 6229 * DURATION (mm-ss):03-50

differences $\underline{\Delta}$T in IC devices that also can be used in the analysis and simulation of thermal heat flow problems.

-Please replace paragraph 39 with the following amended paragraph:

[0039] $\underline{\nabla V}$=voltage gradient;

-Please replace paragraph 42 with the following amended paragraph:

[0042] we note that permittivity $\underline{\varepsilon}$ is close to zero within a conductor. Thus, the permitivity function $\underline{\varepsilon}$(x,y,z) contains a description of the geometry of the system relative to the coordinates of the conductors. Further, integration of Poisson's equation over (x,y,z)-space can be performed assuming a boundary condition of constant potential for the applied voltage within the conductor. The integration of Poisson's equation produces the capacitance matrix C of capacitances C_{ni} between the conductors that describes the charges on the conductors as a result of the applied voltages.

-Please replace paragraph 45 with the following amended paragraph:

[0045] $\underline{\kappa}$ = thermal conductivity; and

-Please replace paragraph 48 with the following amended paragraph:

[0048] The approximation discussed above for the thermal case is not as good as the electrical case since the difference in the thermal conductivity between insulator and conductor is only one to two orders of magnitude. In contrast, in the electrical case the different regions are several orders of magnitude different. However, accepting the approximation discussed above, both the Poisson and the heat equation become identical except for a scalar factor F. The scalar factor F describes the relationship between thermal conductivity ($\underline{\kappa}$) and electrical permittivity ($\underline{\varepsilon}$) for a given material. The scalar factor F is given as:

$\underline{F=\kappa/\varepsilon.}$

PAGE 3/14 * RCVD AT 5/31/2005 4:13:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-1/3 * DNIS:8729306 * CSID:202 293 6229 * DURATION (mm-ss):03-50

-Please replace paragraph 56 with the following amended paragraph:

[0056] $\underline{C_{ni}}$=capacitances,

-Please replace paragraph 58 with the following amended paragraph:

[0058] The situation discussed above is further illustrated in Fig. 1a. An integration over the geometry of conductor 1, conductor 2, and conductor 3 can be done from negative infinity to positive infinity with a three-dimensional finite element problem solver (e.g., FEMLAB) along x, y, and z axes, as shown in Fig. 1a. Either the voltage or temperature is set to a constant on the surface of the conductor to establish the boundary conditions. The three-dimensional finite element problem solver determines the familiar matrix equation between the conductors:

$$\underline{P_n = \sum_i^m \frac{\Delta T_{ni}}{R_{thi}} = \sum_i^m G_{thi} \Delta T_{ni},} \qquad (3a)$$

-Please replace paragraph 60 with the following amended paragraph:

[0060] $\underline{\Delta T_{ni} = T_n - T_i}$ = temperature difference at the nth conductor due to alternating current flow in conductor *i*;

-Please replace paragraph 62 with the following amended paragraph:

[0062] $\underline{G_{thi}}$ = thermal conductance of conductor *i*; and

-Please replace paragraph 64 with the following amended paragraph:

[0064] In particular, the case of three conductors in a single plane is shown in FIG. 1a. This corresponds to m=2 in Equation (3a). Additional examples would <u>have</u> included the two-dimensional case where m=4 and the three-dimensional case where m=6. The temperature

PAGE 4/14 * RCVD AT 5/31/2005 4:13:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-1/3 * DNIS:8729306 * CSID:202 293 6229 * DURATION (mm-ss):03-50

difference ΔT_{ni} at the nth conductor due <u>to</u> the ith conductor is generated by the alternating current flow in the ith conductor.

Please replace paragraph 97 with the following amended paragraph:

[0097] FIG. 2 is an exemplary flow diagram of a method for performing an EM check for conductors with alternating current flow adjacent to conductors with direct current flow in an integrated circuit. The values for resistances R_{WIRE} and capacitances C_{ni} associated with the capacitance matrix C of the device are determined in step 201. A non-limiting example of the form in which these capacitances are provided is the capacitance matrix C. The values for capacitance C_{ni} are converted into thermal conductances G_{thi} by multiplying each value by the scalar factor F given by a ratio of thermal conductivity K to permittivity $\underline{\varepsilon}$ of the material (i.e., $F=\underline{\kappa/\varepsilon}$) at step 202. In step 203, the thermal conductances G_{thi} are used to determine the temperature differences ΔT_{ni} between conductors. In step 204, the power flow P_n into a nth conductor or wire with direct current flow is approximated by the summation of the product of the temperature differences ΔT_{ni} between conductors and the thermal conductances G_{thi} due to alternating current flow in adjacent conductors or wires. The power limit is determined in step 205 using the maximum temperature difference ΔT_{MAX} that ensures the reliability for the wire, conductor or device being checked and the expression of Equation (4). This value for the power limit is used to limit the power generated in the conductors with alternating current flow adjacent to a conductor with direct current flow to a value less than the power limit in step 206.

Please replace paragraph 98 with the following amended paragraph:

[0098] FIG. 3 is an exemplary flow diagram of a method for performing an EM check for conductors with alternating current flow adjacent to conductors with direct current flow. The values for resistances R_{WIRE} and capacitances C_{ni} associated with the conductors are determined in step 301. A non-limiting example of the form in which these capacitances are provided is as individual values of capacitance C_{ni}. The values for capacitance C_{ni} are converted into thermal conductances G_{thi} by multiplying each value by the scalar factor F, where F is the ratio of

PAGE 5/14 * RCVD AT 5/31/2005 4:13:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-1/3 * DNIS:8729306 * CSID:202 293 6229 * DURATION (mm-ss):03-50

thermal conductivity κ to permittivity $\underline{\varepsilon}$ of the material (i.e., $F=\underline{\kappa/\varepsilon}$) at step 302. In step 303, the thermal conductances G_{thi} are used to determine the temperature differences ΔT_{ni} between conductors. In step 304, the power flow P_n into the nth conductor with direct current flow is approximated by the summation of the product of the temperature differences ΔT_{ni} and the thermal conductances G_{thi} due to adjacent conductors with alternating current flow. The power limit is determined in step 305 using the maximum temperature ΔT_{MAX} that ensures reliability of the wire being checked and the expression of Equation (4). This value for the power limit is used to limit the power generated to less than the power limit in step 306.

PAGE 6/14 * RCVD AT 5/31/2005 4:13:32 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-1/3 * DNIS:8729306 * CSID:202 293 6229 * DURATION (mm-ss):03-50